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AUTHOR	Magne, Olof
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ABSTRACT

This bibliography is a survey of literature on dysmathematics and contains lists of documents in the areas of philosophy, neuropsychology, sociology, education, and technology. Specifically chosen themes include educational and social needs, physical impairment, affect and motivation, ability, memory, and gender. It includes inferences concerning the many authors' selection of their topics. Inferences are grouped under notions on the nature of mathematics, mandates to mathematics special education, thematic interests of the authors, interest in specific traits or special needs, causes for mathematical disability, and educational principles and remediation methods. (JRH)

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BIBLIOGRAPHY OF LITERATURE ON DYSMATHEMATICS

With some comments

Olof Magne

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Students with special educational needs sometimes display poor retention of mathematics. For such low achievement the author uses the technical term "Dysmathematica". For ordinary educational purposes the author prefers less defect orientated expressions, as "to fail in mathematics learning". Is the low achievement a consequence of their impairment, or wrong learning strategies, unwise special teaching traditions etc? Mathematics learning has been subjected to many conflicting impulses, not always favourable.

This documentation presents an assortment of documents that have been published in one or another form during a long time, actually since 1886 and up to this year.

Keywords: Bibliography, disability, dysmathematics, individualisation, mathematics, special education.

Definitions

The expression *Special educational needs in mathematics* is often used for the condition when a student fails in his/her efforts to master one or several main areas of mathematics according to set standards..

In 1988 Magne introduced the technical term *Dysmathematica*, or Dysmathematics. Terms like Arithmasthenia (Ranschburg, 1905), Acalculia (Henschen, 1920) and Dyscalculia (Gerstmann, 1924) refer to low achievement in arithmetic.

Dysmathematical behaviour must be looked upon from a relativist view. The assessment depends on the learning or instructional criteria of the prevailing educational conditions, traditions or legislation. Obviously, standards may vary from one school system to another. The condition may refer to a given occasion or to a defined period of the individual's life.

The definitions of the condition in view are often based upon

* either a statistical measurement, such as 1 to 1.5 standard deviation units below the mean of a normal population as to a defined mathematical type of task,

* or a certain fixed criterium, irrespective of population, for example that the student shall achieve 90 per cent of a certain measurable aspect of mathematics.

Introduction

This is not the first attempt to summarize literature on dysmathematica. Bibliographies of mathematical low achievement are found, for instance, in Fleischner and Garnett (1980); Matulis (1981); Lorenz (1982); Fletcher and Loveland (1986); Bley (1987); Grissemann and Weber (1989); König (1989) and Magne (1989).

This survey of the literature is by no means a complete catalogue of all existing documents but it may be the most extensive. First of all, there are many records of research or practical work that are not printed or in other way offered to the public. Secondly, many documents are available in languages that are difficult to assimilate or understand. Thirdly, some documents refer to infrequent conditions, complaints or impairments and, thus, are seldom available to persons outside a very exclusive circle of specialists.

The writer has tried to obtain documents from the following areas in connection with mathematical disability:

philosophy
neuropsychology
sociology
education
technology.

Specifically chosen themes are for instance: Educational and social needs, physical

impairment, affect and motivation, ability, memory, gender.

It is the hope of the author that by cooperation the present bibliography can be considerably extended gradually when a new version may seem desirable.

The present material has been subjected to quantitative and qualitative categorization although the reader may be better assisted by himself or herself if he/she elaborates a register from this biographical material fitting his/her own interests. The reason is that there are many conceivable criteria for such categorizing attempts, due to various value judgments, ideologies or practical purposes.

It may be useful to introduce some examples of such criteria.

One important comprehensive value perspective has to do with the official choice of policy for education and socialization of individuals. One point of departure for the State's Authority for Education may be looked upon as a *mandate* for the Administration to work out systems for transmitting or impressing a certain uniform, regimented civil preparedness upon the minds of all citizens. A consequence of this value objective is that authorities tend to decree a standardized, or "National", curriculum with equal specifications for everyone concerning knowledge, skills, moral concepts etc.

A second *mandate* to consider may be founded on a principle of options for the individual to meet personal interests and talents. According to such a principle, the individual is guaranteed a right of self-determination, for instance regarding schooling, modelling his/her curriculum, strategies for learning or tutoring, choice of instructional aids etc. This mandate may very well clash with the official uniformity mandate and, therefore, seems to be unusual in the administrative legislation.

A possible third *mandate* may refer to groups of citizens, in an informal or formal sense, to give them opportunities to attain certain insights in their respective activities, according to their interests. Co-operating groups might wish to enable themselves to organize or reorganize their own further education or revise their operative conditions. For teachers, this mandate would include self-assertion and self-government in matters related to their own collective sphere of activity. This type of mandate is common in the educational world.

A second comprehensive value perspective concerns the thematic field of dysmathematica.

One aspect would be to start from the mathematical subject matter. Research would mean to study the students' difficulties to attain certain fixed competences in the various main areas of mathematics. Apparently, in the traditional school systems this was a usual foundation for investigating the trouble the teachers experienced when they instructed their students. One consequence of this approach was a belief that only some students were able to acquire mathematical knowledge and that the other students had better do something else. Related to dysmathematics this approach has been described as the *content deviation model.* The remedy would be partly not to do mathematics, partly to assign to the students tasks on the appropriate optional level of mathematical complexity.

A contrasting approach is to base the corresponding research on bodily conditions, for instance to study neuronal impairment, and follow up on the consequences for mathematical achievement. Some early anatomical and histological investigations worked from this methodological basis. Today we find that neuropsychologists like to use this method. They seem to believe that, by diagnosing brain functions, tuition will get a foundation for sound strategies and consequently give educators and therapists a sound means to habilitate or rehabilitate a dysmathematical student properly. In relation to dysmathematics, this approach may be called the *behaviour deviation model.* The treatment consists in various forms of organic and mental therapy.

A third starting-point might be to study the social and psychological prerequisites that trigger the reactions of the thinking/learning students when they are brought face to face with mathematics topics. After D'Ambrosio's introduction of ethno-mathematics a great deal of arguments have been presented in favour of alternative mathematics. To some extent the traditional formal types of topics have seemed justified and been supplemented with informal didactics characterised by a social or sociological bearing. Obviously, research has so far been unable to prove that organic lesions play more than a marginal part in the learning of mathematics even for the dysmathematical students. It is usual to find that the supposed proportion of brain injuries among dysmathematics students cause no more than about 20 per cent of the dysmathematica. This fact makes it unrealistic to fully accept both the content deviation model and the behaviour deviation model to one hundred per cent. It also seems necessary to concede that mathematical knowledge is not an objective reality but constructed by the human mind. The content deviation model seems to be valid only when due consideration is taken to the learner's mind, beliefs and attitudes. On the other hand, the behaviour deviation model seems to have no validity on its one, namely if the subject matter of mathematics is disregarded. Content and behaviour balance each others. This third approach appears to be more realistic. It has been called the *factor-interplay model.* The corresponding remediation would be to give individual tuition with great freedom for the educator and the student to select mathematical options according to the student's interests and personal circumstances.

An additional value perspective refers to research on specified varieties of dysmathematica per se. As a "syndrome" (seen from a neuropsychological point of view) or a "special educational need" (seen from a socio-educational aspect) dysmathematica calls for a good diagnosis and a well defined programme of tuition, treatment and habilitation. Some authors maintain that the student always should be looked upon as having a central position in education and claim that it is essential for the dysmathematical students to get individual tuition. Dysmathematics manifests itself in many shapes, from very mild trouble, indicating momentary need for counselling, to severe physical disablement, making it necessary to provide intensive programmes of tuition, medical treatment and social therapy. In some cases the dysmathematics displays reduced attainment in a solitary mathematical topic area, possibly accidentally. In severe cases the overall capacity for learning mathematics is extremely low although

it must be stressed that research about them is very poor. Students with similar characteristics can have similar needs. Thus, the blind, deaf, physically disabled, mentally handicapped, phobic and emotionally disturbed students, respectively, may, as kindred groups show similar, typical learning reactions due to their specific physical or mental dispositions.

Blind students are at a disadvantage because they have a handicap to visualise.

Deaf students may be linguistically impaired.

Emotionally disturbed students may display a disordered state of mind.

Physical impairment often inhibits the growth of form perception and geometric notions.

Summarizing research, mathematical low-achievement and underachievement appear as complex and multi-factored disabilities. Many children ought to be treated not only with respect to the learning needs in mathematics but, in addition, to several other needs as well. We may find it well-advised to look at each individual student as unique. One inference of this analysis is that planning for mathematical tuition must emphasis *both* learner *and* subject matter, *both* teacher *and* student. The relationship between student and school organisation is also very complex. The mathematics special needs student is sometimes unable to adapt him/herself to a national curriculum. A special programme should be worked out. The tuition can often be conducted in the classroom. Severe learning needs may or may not be able to treat in the regular classroom.

Interpretations

From the present categorization of the documents in the bibliography it seems possible to make a few inferences concerning the many authors' selection of their topics.

A. Notions on the nature of mathematics.

1. According to this bibliography a majority of the authors seem to look at special needs mathematics as identically the same as mathematics in the recognised official curriculum for the regular school system at issue.
2. Alternative and informal mathematic topics are lately being discussed by a few authors in connection with ethnic circumstances.
3. The most frequently investigated part of mathematics is arithmetic, most common is addition with one- or two-digit numbers (numerals). Surprisingly, it is usual that authors study and describe unsophisticated tasks.
4. Investigations are rare in the field of secondary mathematics and university mathematics but during the latest two or three decades a beginning literature is emerging..
5. The neuropsychological studies seldom comprise other mathematical areas than

the most elementary types of number notions or calculations.

6. In neuropsychological studies it is usual to find confusion between reading, writing and simple arithmetic.

B. On mandates to mathematics special education.

1. The overwhelmning amount of authors in this bibliography seem to start from the presumption that mathematics for the special needs student should contain mathematical topics and exercise, presented in the same way, and have the same structure and function as for other students. The authors' usual standpoint is that official curriculum standards ought to followed in order to remediate the mistakes of the special needs student in a correct way.
2. Individual programmes and group work are surprisingly seldom described, discussed or analysed in connection with students with special mathematical needs.
3. There is an apparent lack of studies on how teacher education should take place in order to prepare the trainees for competence to take care of students with special mathematical needs.

C. The thematic interests of the authors.

1. The most common approach to the various topics seems to be to promote mastery of the mathematical content (may indicate tuition according to the content deviation model).
   a. Diagnostic studies are frequent, and they often aim at establishing the achievement levels of special mathematical needs students or to relate these students results to those of a normal population or to fixed standards. This is particularly obvious in studies concerning attainment of students with visual and hearing impairment.
   This type of investigation is also very popular in studies of mentally handicapped. It is apparent that the studies of mathematical learning among mentally retarded students mainly is directed towards numeration, calculation or visual forms, not the experiences of the students or their thinking/reasoning.
   b. Error studies are very common. A usual procedure is to describe misunderstandings, miscalculations, misreadings or false connclusions related to mathematical "concepts", rules or algorithms that are fixed by the curriculum.
   c. Even neuropsychological studies often seem to refer to basic mathematical formal standards rather than socio-educational reaction patterns.
2. In some studies mathematical errors are interpreted as results of erroneous judgment, slips of the tongue, wrong concentration, verbal misinterpretation etc. This may be characterizied as belief in the behavior deviation model.
3. Many authors are concerned about organic impairment, exclusively, for instance lesions to the nervous system (behaviour deviations).

4. Anxiety is a vey common theme, usually in one or both of two varieites: mathematics anxiety and test anxiety, where learning conditions or instructional conditions are looked upon as instrumental to the anxiety. The building up of mathematics anxiety is sometimes looked upon from the behaviour deviation model. Sometimes the mathematics anxiety is explained with reference to the content deviation or the factor interplay model.
5. Since one or two decades ago the interest has increased among authors to relate special mathematics needs to social and ethnic factors.
6. Motivation, attribution and belief theories as well as the self-efficacy conception have been considered as causal factors. An increasing number of authors tend to take up these themes.

D. Interest in specific traits or special needs.

1. The majority of the documents deal with general conditions which are noticed among ordinary students in regular classes, usually very mild disabilities o educational needs with small discrepancies from statistical standards.
2. Mental handicap is the most frequently studied form of special need. These studies most often deal with mild learning disability. Severe mental handicaps are rather neglected.
3. A small number of authors have tried to investigate relations between language disabilities (so-called dyslexia) and special cases of under-achievement in mathematics.
4. There has been a limited interest in underachievement in mathematics. In some countries results from this research seem to have started animated discussions.
5. One popular topic is mathematics anxiety.
6. Mathematical attainment and needs of socially and emotionally disturbed students have attracted only slight attention. This also holds for criminality and psychotic conditions.
7. Remarkably few authors have attempted to investigate mathematics achievement of visually and hearing impaired persons (Less than one per cent of the documents). These contributions most often contain statistical data or sundry factual specifications.
8. Only few investigators have taken up the issue how mathematics is learnt by students with a visual or hearing impairment.
9. There is also a lack of studies on the problem how students with emotional or social disturbances learn mathematics.

E. Causes for mathematical disability.

1. The symptomatology of dysmathematics seems to be very popular theme.
2. Some authors claim that they have found a causal relationship between some very simple arithmetic skills and neurological lesions to frontal, occipital and parietal lobes of the left hemisphere. Some parts of the right hemisphere are described as

sites of geometrical skills and possibly problem solving skills.

3. As to more complex mathematical topics there is no proved relationship between neuronal functions and mathematical achievement.

4. There are only vague unverified hypotheses concerning causal genetic factors and mathematical ability.
5. Interrelations also seem to be very complex between social conditions and mathematical ability and mathematical achievement.
6. Some authors claim that they have found circumstantial evidence that some types of instruction can cause low achievement in mathematics. One such condition could be mechanical training, based upon associationistic learning principles.
7. There are few effective studies which have succeeded to demonstrate clear causes for difficulty to learn mathematics. According to the accessible literature mathematics special needs students display a very complex behaviour profile.

F. Educational principles and remediation methods

Many authors in the bibliography have written about methods how to treat low achievers in mathematics. These methods may be described as remediation. The methods can be roughly characterised as medical, educational, psychotherapeutic and social (sociological).

The authors usually write about the mild complaints. There is very little research reported on the treatment of severe cases, and apparently this refers to all sorts of impairments, disabilities or handicaps. Mild complaints are usually treated educationally and socially, for instance the educationally sub-normal children. Severe and moderate difficulties of all kinds are sometimes given a mixed treatment.

The majority of the authors describe only mild learning disabilities where the students get various forms of educational tuition.

To a great extent the bibliography reveals that there are various kinds of grave controversies, for instance

* philosophical realism - epistemological constructivism,
* associationism/behaviorism - psychodynamism,
* instruction - learning,
* behaviour modification - spontaneous discovery,
* drill - understanding,
* verbal explanation - practical realism
* frontal teaching - individualised discourse,
* whole-class lecturing - small group tuition,
* external motivation - internal motivation.

Many authors try to justify their irreconciliable contrasting opinions by reference to educational philosphies, theories of cognition and political ideas. One explanation to the controversial positions may be lack of comprehensive research projects and, as a consequence, inconsistent research documentation. Many authors report studies on a

small scale and/or refer to extremely specific situations. There are few reports on large-scale, well-designed projects on remediation of dysmathematics which could be looked upon as pioneer work and served as model projects or prototypes for future studies. There are a few exceptions. The following examples may be mentioned: The Finnish-Swedish mathematics clinics experiment (Ikehäimo and Magne et al.) and the Hungarian realistic, experimental teaching in special schools (Tarnai and Varga et al.).

A critical comment might be that, unfortunately, researchers on remediation seem to have selected experimental problems and procedures more or less by trial and error and examined the outcome hap-hazardly. The research development may have let circumstances decide in a spontaneous way, and passing fancies could have been more influential than well-structured presumptions.

A recommendation would be that prospective investigations should be better organised, focus on cardinal issues and build upon carefully prepared cooperation between nations and universities.

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Compiled for further elaboration and categorization

by
Olof Magne

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Abstract card

Magne, O. Bibliography of literature on dysmathematics: With some comments. *Didakometry* (Malmö, Sweden: School of Education), No. 76, 1996.

Students with special educational needs sometimes display poor retention of mathematics. For such low achievement the author uses the technical term "Dysmathematica". For ordinary educational purposes the author prefers less defect orientated expressions, as "to fail in mathematics learning". Is the low achievement a consequence of their impairment, or wrong learning strategies, unwise special teaching traditions etc? Mathematics learning has been subjected to many conflicting impulses, not always favourable.

This documentation presents an assortment of documents that have been published in one or another form during a long time, actually since 1886 and up to this year.

Keywords: Bibliography, disability, dysmathematics, individualisation, mathematics, special education.

Reference card

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